NEW YORK HEART ASSOCIATION

Scientific Session on Research held at The New York Academy of Medicine, April 23, 1962

PART II—ABSTRACTS OF PAPERS SUBMITTED FOR PRESENTATION

*The Polarity of the P Wave as a Diagnostic Sign**

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The effect of the site of origin and direction of spread of atrial excitation on the polarity of the P wave has been investigated in normal, closed-chested dogs. Small bipolar silver electrodes were placed near the SA node and on the right atrial appendage, the left atrial appendage, adjacent to the coronary sinus, and on the right ventricle. The coronary sinus electrodes were attached during inflow occlusion. One week, or longer, was allowed for the dogs to recover from the surgical procedure before electrical stimulation of the different electrodes was carried out.

The P wave during normal sinus rhythm was upright in leads II, III and aVF and negative in aVR and aVL. Driving the heart through electrodes near the SA node and on the right atrial appendage or coronary sinus resulted in no major change in the polarity of the P wave in these same leads. Stimulation of the left atrial appendage produced P waves which were nearly flat. From these studies it appears that, in canine hearts, the P wave is not inverted when the spread of excitation begins at the AV nodal region. It may be concluded, therefore, that an inverted P wave on the electrocardiogram may not be a diagnostic sign of an AV nodal rhythm.

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*Postvalvular Pulmonary Artery Stenosis**

HEMODYNAMIC AND RADIOLOGIC DEFINITION

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Postvalvular pulmonary artery stenosis has been recognized with increasing frequency with the widespread application of cardiac catheterization and angiocardiography. The stenosis may be unilateral or bilateral, single or multiple, mild or severe, localized areas of narrowing at any point in the course of the pulmonary artery. The anatomic block is associated physiologically with a systolic pressure gradient across the area of narrowing and with parasternal systolic or continuous murmurs.

In a series of right-heart catheterizations in 175 cases of suspected congenital heart disease, constriction of the pulmonary artery distal to the valve was found in 14 patients. The right main pulmonary artery was the site of constriction in seven patients, both main pulmonary arteries in six patients, and in a single patient constriction was confined to a peripheral artery. The systolic pressure gradient across the narrowed artery ranged from 7 mm. to 115 mm. Hg.

Postvalvular pulmonary artery stenosis was the only defect defined in six cases, pulmonary valvular stenosis was coexistent in two cases, atrial septal defect in one case, and in the remainder multiple congenital defects were demonstrated.

Physical signs are not diagnostic. Consequences of the lesion range from a soft systolic murmur at the base, suggesting an innocent origin in cases of mild isolated postvalvular stenosis, to findings of a harsh systolic murmur, loud P_2 and EKG evidence of right ventricular hypertrophy in cases of severe constriction. In the presence of an associated cardiovascular defect, the clinical signs reflect the other defect, i.e., Tetralogy of Fallot, atrial septal defect, aortic stenosis, pulmonary valvular stenosis, or patent ductus arteriosus. In no instance was a continuous murmur attributable to postvalvular stenosis.

The diagnosis is established by measuring a definite systolic pressure gradient which is repeatedly demonstrable in one or more pulmonary arteries. Proximal to the stenosis the pulmonary artery shows a wide pulse pressure and a low dicrotic notch. Selective angiograms and cineangiograms further define the area of constriction which may be localized or extend for 3 or 4 cm., and which are usually associated with post-stenotic dilatation of the pulmonary artery.

A postmortem injection cast in one case defines bilateral localized narrowing of both main pulmonary arteries. Microscopic examination of narrowed segments showed no abnormalities.

Postvalvular pulmonary artery stenosis is probably more common than is recognized at present. This entity should be considered as a cause of innocent murmurs in mild narrowings, and as a cause of pulmonary artery and right ventricular hypertension in severe bilateral constrictions.

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** Vincent Youman Memorial Research Fellow in Medicine.

*Lymphography**

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The study of lymphatics by contrast media was first described by Kinmonth. Our method, which consists of some modifications of the Kinmonth technique, has been performed in 30 patients.

We have been able to demonstrate successfully the lymphatics of the upper and lower extremities, to include the retroperitoneal region, the inguinal, iliac, periaortic, and axillary nodes.

The technique, briefly, is as follows:

One-half ml. of Alphazurine-2G (Fougera) is injected intradermally into the web space between the first and second toes or into the thenar eminence of the hand. A small curved incision is made several inches away from the web space and the fine lymphatic trunk, which has been stained by the dye, is isolated. Using a 27 gauge hypodermic needle attached to a fine polyethylene tube, the lymphatic vessel is cannulated. Ten ml. of Ethiodol (Fougera) is injected over a 60- to 90-minute period, using an electric pump or a gravity pump. No serious complications have occurred in the above series.

RESULTS

Six patients were studied who had stasis ulcers believed due to chronic varicose veins. In the region of the ulcers, a lacework of fine lymphatics was visualized in each instance. This is in marked contrast to the appearance of lymphatics in normal lower extremities. We suspect that the lymphatics play a significant, but as yet unexplained, role in the form of stasis ulcers.

Lymphograms were performed in four patients with malignant melanomas. In two of these cases we were able to make the diagnosis of inguinal node metastasis based on the lymphographic study.

In one case of carcinoma of the breast we were also able to make a preoperative diagnosis of axillary node metastasis. Confirmation of these diagnoses was established by pathological examination of the involved nodes.

In an unusual case of chyluria we were able, on the basis of lymphography, to determine that the right kidney was involved with findings suggestive of lymphangioma.

CONCLUSIONS

With our limited experience, we are still learning about the behavior of lymphatics in certain disabling inflammatory conditions and in certain malignant conditions. Our experience to date, and that of others, is too limited to draw absolute conclusions. However, sufficient evidence has been accumulated to justify continued investigation of the lymphatics in animals and man using the above technique.

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*Prevention or Delay of Ventricular Fibrillation by Mechanical Assistance to the Ischemic Heart**

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Whereas pump-oxygenators have been used extensively for open-heart operations during the past eleven years, few workers have advocated use of the pump-oxygenator as an assist to the failing and/or ischemic heart. Dennis and co-workers have recently described a technique of left ventricular by-pass without thoracotomy; a stainless steel curved-tip cannula, inserted via the right internal jugular vein, is used to perforate the fossa ovalis to enter the left atrium. Oxygenated blood can thus be drained and pumped into the distal arterial tree to effect quantitative left ventricular bypass. Further studies have shown that left ventricular by-pass decreases oxygen utilization of the myocardium in proportion to the degree of by-pass.

We have expanded the investigations to determine whether complete left ventricular by-pass and/or partial cardiopulmonary by-pass will prevent or delay the onset of ventricular fibrillation caused by coronary arterial occlusion. Tables and graphs are offered to show that the heart is afforded definite protection against ventricular fibrillation when assisted either by partial cardiopulmonary bypass or by left ventricular bypass.

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*A Study of the Effect of Left Ventriculotomy upon Epicardial Activation**

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By utilizing cardiopulmonary bypass and surface electrodes the activation sequence of the epicardial surface of the left ventricle was studied in dogs before and after left ventriculotomy and also before and after left bundle-branch block. An 8 to 10 cm. longitudinal ventriculotomy incision was made through the mid portion of the left ventricle, care being taken not to compromise the major blood supply of the ventricle. Block was obtained by transecting the left common bundle. Electrical activity at the surface electrodes was monitored on an oscilloscope and photographed on paper moving at 200 mm./sec. The temperature of the dog was monitored by a thermistor and was kept constant throughout the experiments; lead II of the standard electrocardiogram was also monitored.

Following left ventriculotomy no delay or change in sequence occurs in the activation of the epicardium of the left ventricle. Following left bundle-branch block the pattern of epicardial activation is changed, the earliest points being adjacent to the interventricular grooves anteriorly and posteriorly, and becoming progressively more delayed towards the mid portion of the left ventricle. Thus, it would appear that following left bundle-branch block the epicardial surface of the left ventricle adjacent to the interventricular grooves is activated by impulses passing from the right ventricle, while the more centrally located portion is activated either by conduction in muscle or delayed local reactivation of Purkinje fibers.

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*Effect of Variation in Sodium Excretion on Free-Water Clearance in Normal Man**

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The kidney's ability to elaborate solute-free water (C_{H_2O}) has been thought to depend upon sodium extraction at the diluting site(s) of the nephron. Increases in C_{H_2O} during osmotic loading could be attributed to increased delivery of sodium to the ascending limb and distal convoluted tubule.

To examine this thesis, C_{H_2O} was measured during mannitol and urea diuresis in subjects in whom dietary sodium intake was varied.

C_{H_2O} increased in a similar fashion with urea and mannitol loading, although urinary sodium osmotic fractions (OF_{Na}) were lower when urea was used. Threefold increases in OF_{Na} induced by changes in diet did not enhance C_{H_2O} during mannitol diuresis.

These data suggest that the increase in C_{H_2O} observed during osmotic loading may not be due solely to increased delivery of sodium to the diluting site(s).

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*The Prevention of Air Embolism During Cardiopulmonary Bypass**

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This laboratory has previously reported on the role of position in the development of cerebral air embolism following air injection at the base of the aorta. Further studies are concerned with the fate and effect of air entering the femoral artery with blood from the pump-oxygenator during open-heart surgery. The appearance of air in the mesentery and in the right kidney was monitored visually; the amount of air to the head was quantitated by placing a bubble trap in the common carotid arteries.

Our studies appear to justify the following conclusions: 1) The head-down position offers a statistically significant degree of protection when air is injected at the base of the aorta. 2) Air has been demonstrated to remain trapped in the arch of the aorta for periods up to thirty minutes. 3) The Trendelenburg position offers some protection against gas introduced by faulty extracorporeal equipment. 4) Controlled amounts of air introduced into the perfusion system through the femoral artery cannula are consistently observed in the mesentery of the bowel before it appears in the common carotid arteries. These observations should be of interest to those working with cardiopulmonary bypass.

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*Studies on the Use of ACD Blood During Perfusion**

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It was the object of this study to investigate the use of ACD blood in perfusion. Ten adult mongrel dogs underwent total body perfusion for 30 minutes at normothermic temperatures. All blood used in this experiment was collected in Acid Citrate Dextrose Solution B, as used in the Kings County Hospital Center blood bank, and stored for periods varying from 1 to 6 days. Four units of blood were used to prime the circuit. Thirty mg. of heparin and from 0.2 to 1.0 gm. of $CaCl_2$ were added to each unit of blood used in the circuit. Lead II of the standard EKG and femoral artery pressure were monitored throughout. Serum K, Na, CO_2, Cl, Ca, along with pH, plasma hemoglobin and hemoglobin were determined on the priming blood, the perfusion dog at various intervals before, during and after perfusion, and on the donor dogs. At the end of the perfusion the excess heparin was neutralized with protamine. A comprehensive blood coagulation workup pre-perfusion and two hours postperfusion was carried out in each dog.

Of the 10 dogs perfused, 9 survived for 24 hours or longer, and were sacrificed at specific intervals. Two of the dogs developed evidence of marked metabolic acidosis along with generalized oozing after the conclusion of perfusion. The single operative mortality is in this latter group. One other dog exhibited generalized oozing. The changes in blood coagulation data obtained postoperatively in all the animals are similar to those seen when freshly drawn heparinized blood is used. From these results it may be stated that it is possible to perfuse dogs with ACD blood and have them survive. The problems encountered in this study are undergoing further evaluation.

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